

WHAT IS CLAIMED IS:

1. A balanced amplifier comprising:  
a pair of voltage-to-current converters each  
including

5 a first input terminal,  
a second input terminal,  
a first output terminal and  
a second output terminal,  
each of the voltage-to-current converters  
10 converting differential input voltages applied to the  
first input terminals of the converters into output  
currents output from both of the first output terminal  
and the second output terminal of each of the  
converters;

15 wherein the second input terminals and the second  
output terminals of the converters are connected in  
common to cancel common-mode components and extract  
differential components.

2. The balanced amplifier according to claim 1,  
20 wherein each of the voltage-to-current converters  
comprises a common source amplifier.

3. The balanced amplifier according to claim 1,  
which further includes a first impedance connected  
between the first input terminal and the first output  
25 terminal of one of the converters and a second  
impedance connected between the first input terminal  
and the first output terminal of the other of the

converters.

4. The balanced amplifier according to claim 3,  
which includes a first input side impedance connected  
to the first input terminal of one of the converters  
5 and a second input side impedance connected to the  
first input terminal of the other of the converters.

5. A balanced amplifier comprising:

a first voltage-to-current converter and a second  
voltage-to-current converter, each of the first  
10 voltage-to-current converter and the second voltage-to-  
current converter including

a first input terminal,  
a second input terminal,  
a first current source which outputs a first  
15 current,  
a second current source which outputs a second  
current,  
a first output terminal outputting a third current  
and

20 a second output terminal outputting a fourth  
current,

wherein the third current is obtained by  
subtracting a sum current from the first current,  
the sum current corresponding to sum of currents  
25 corresponding to voltages applied to the first input  
terminal and the second input terminal respectively,  
and the fourth current being obtained by subtracting

the sum current from the second current, and

wherein the second input terminal and second  
output terminal of the first voltage-to-current  
converter and the second input terminal and second  
5 output terminal of the second voltage-to-current  
converter is connected in common, a differential input  
signal is input to the first input terminals of the  
first voltage-to-current converter and the second  
voltage-current converter, and a differential output  
10 signal is output from the first output terminal of the  
first voltage-to-current converter and the second  
voltage-current converter.

6. The balanced amplifier according to claim 5,  
which includes a first impedance element connected in  
15 parallel to the first voltage-to-current converter  
between the first input terminal and the first output  
terminal of the first voltage-to-current converter, and  
a second impedance element connected in parallel to the  
second voltage-to-current converter between the first  
20 input terminal and the first output terminal of the  
second voltage-to-current converter.

7. The balanced amplifier according to claim 6,  
which includes a plurality of impedance elements each  
supplied with the differential input signal, wherein at  
25 least one of the plurality of impedance elements is  
connected to the first input terminal of each of the  
converters.

8. The balanced amplifier according to claim 6, which includes a plurality of single input/single output voltage-to-current converters to which the differential input signal is supplied, and wherein at least one of the plurality of the single input/single output voltage-to-current converters is connected to the first input terminal of each of the converters.

9. A filter comprising the balanced amplifier according to claim 6.

10. The balanced amplifier according to claim 5, which further comprises a third voltage-to-current converter having a configuration equal to that of the first voltage-to-current converter and the second voltage-to-current converter, and wherein a first input terminal and an output terminal of the third voltage-to-current converter are connected to the first input terminal of the first voltage-to-current converter, and a second input terminal and a second output terminal of the third voltage-to-current converter are connected to the first input terminal of the second voltage-to-current converter.

11. The balanced amplifier according to claim 10, wherein each of the first voltage-to-current converter, the second voltage-to-current converter, and the third voltage-to-current converter comprise a third input terminal and a fourth input terminal, and the first current source and the second current source supply

a sum current corresponding to sum of the currents corresponding to voltages applied to the third input terminal and the fourth input terminal to the first output terminal and the second output terminal of each of the first voltage-to-current converter and the  
5 second voltage-to-current converter.

12. The balanced amplifier according to claim 10, wherein each of the first voltage-to-current converter, the second voltage-to-current converter and the second  
10 voltage-to-current converter includes a first power line and a second power line, and two transistors connected in series between the first power line and the second power line.

13. A filter comprising the balanced amplifier  
15 according to claim 10.

14. The balanced amplifier according to claim 5, wherein each of the first voltage-to-current converter and the second voltage-to-current converter comprise a third input terminal and a fourth input terminal, and  
20 the first current source and the second current source supply a sum current corresponding to sum of the currents corresponding to voltages applied to the third input terminal and the fourth input terminal to the first output terminal and the second output terminal of  
25 each of the first voltage-to-current converter and the second voltage-to-current converter.

15. The balanced amplifier according to claim 5,

wherein each of the first voltage-to-current converter and the second voltage-to-current converter includes a first power line and a second power line, and two transistors connected in series between the first power  
5 line and the second power line.

16. A balanced amplifier comprising:

a first voltage-to-current converter and a second voltage-to-current converter, each of the first voltage-to-current converter and the second voltage-to-  
10 current converter including:

a first input terminal,  
a second input terminal,  
a first output terminal and  
a second output terminal, and

15 each of the first voltage-to-current converter and the second voltage-to-current converter supplying a current corresponding to sum of currents corresponding to voltages applied to the first input terminal and the second input terminal respectively to the first  
20 output terminal and the second output terminal so that a polarity of an output signal from the first output terminal is reversed with respect to a polarity of an input signal to the first input terminal, and a polarity of an output signal from the second output  
25 terminal is reversed with respect to a polarity of an input signal to the second input terminal,

wherein the second input terminals and second

output terminals of the converters is connected in common, a differential input signal is input to the first input terminals of the converters, and a differential output signal is output from the first  
5 output terminals of the converters.

17. The balanced amplifier according to claim 16, wherein each of the first voltage-to-current converter and the second voltage-to-current converter further includes a third input terminal and a fourth input  
10 terminal, and supplies to the first output terminal and the second output terminal a sum current corresponding to sum of currents corresponding to input voltages applied to the third input terminal and the fourth input terminal so that polarities of output signals  
15 from the first output terminal and the second output terminal coincide with polarities of input signals to the third input terminal and the fourth input terminal.

18. The balanced amplifier according to claim 16, wherein each of the first voltage-to-current converter, the second voltage-to-current converter and the third  
20 voltage-to-current converter further includes a third input terminal and a fourth input terminal, and supplies to the first output terminal and the second output terminal a sum current corresponding to sum of  
25 currents corresponding to input voltages applied to the third input terminal and the fourth input terminal so that polarities of output signals from the first output

terminal and the second output terminal coincide with polarities of input signals to the third input terminal and the fourth input terminal.

19. A voltage-to-current converter comprising:

5       a first input terminal,  
       a second input terminal,  
       a first output terminal, and  
       a second output terminal;

       an adder which adds voltage signals supplied to  
10    the first input terminal and the second input terminal  
       respectively;

       a first inverting amplifier which reverses and  
       amplifies an output of the adder;

       a second inverting amplifier which reverses and  
15    amplifies the output of the adder;

       a third inverting amplifier which reverses and  
       amplifies an output of the first inverting amplifier  
       and outputs a first reversed and amplified signal to  
       the first output terminal as a first current signal;

20       a fourth inverting amplifier which reverses and  
       amplifies an output of the second inverting amplifier  
       and outputs a second reversed and amplified signal to  
       the second output terminal as a second current signal;

       a first capacitor connected between an input  
25    terminal and an output terminal of the third inverting  
       amplifier; and

       a second capacitor connected between an input



terminal and an output terminal of the fourth inverting amplifier.

20. A voltage-to-current converter according to claim 19, wherein each of the adder, the first  
5 inverting amplifier, the second inverting amplifier, the third inverting amplifier and the fourth inverting amplifier includes two transistors connected in series between a first power source and a second power source.

21. A balanced amplifier comprising two voltage-  
10 to-current converters each according to claim 19, wherein the second input terminals and the second output terminals of the converters being connected in common, a differential input signal is input from the first input terminals of the converters, and  
15 a differential output signal is output from the first output terminals of the converters.

22. A balanced amplifier comprising:

a first and a second converters, each being a voltage-to-current converter and each including  
20 a first and a second input terminals,  
a first current source supplying a first current,  
a second current source supplying a second current,

a first subtractor generating a third current by  
25 subtracting a sum current representing sum of currents corresponding to voltages applied to the first and second input terminals, from the first current,

a second subtractor generating a forth current by subtracting the sum current form the second current,

a first output terminal outputting the third current, and

5 a second output terminal outputting the fourth current,

wherein both of the second input terminals of the first and the second converters and both of the second output terminals of the first and second converters are  
10 connected in common, and

a differential input signal is applied to the first input terminals of the first and the second converter, thereby obtaining a differential output signal on the first output terminals of the first and  
15 the second converters.